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Preparing individuals for the demands of PSS work environments through a game-based community approach – design and evaluation of a learning scenario

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Abstract

In our paper, we focus on the characteristics of the organizational transformation process that integrates the product and the service paradigm to achieve a Product-Service System (PSS). Due to the outcome of our own research activities and recent literature about the servitization of manufacturing, the transformation towards PSS is considered as an organizational learning and renewal process that has special demands for collective learning and knowledge-sharing activities. These demands are regarded as particularly crucial to manage the integration of the product and service paradigm. For the design of a specific learning scenario that prepares individuals for the demands of PSS work environments and the challenges along this organizational development process, we refer to the 4I Framework of organizational learning as a conceptual background to frame the transformation towards PSS within a context-rich learning environment. The design of the PSS-related learning scenario addresses the challenges of the organizational transformation process towards PSS on the individual, group and organizational level. The role of participants as individual actors in this learning scenario is determined by a PSS-specific 4I Framework as a holistic approach in which learners have to work out strategies to overcome typical barriers of a PSS-related organizational transformation process. The PSS-related learning environment builds on a business game scenario which provides us with the opportunity to address the ambiguity and the dynamic character of the transformation process towards PSS. Furthermore, we outline the advantages of a game-oriented community approach that supports individual learners to understand how to integrate the product and the service paradigm collectively in a fictitious but reality analogous organizational environment.

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Product-Service System, PSS, 4I Framework, Business Gaming, Learning, Organization

1. Introduction

Recent research in the field of Product-Service Systems (PSS) has pointed out the importance of considering a human factor perspective in successfully developing and operating PSS [1]. The special characteristics of PSS work environments, such as a high degree of coordination, communication and knowledge integration activities among manufacturers, service providers, suppliers, and customers, increase the demands for individual actors regarding collective learning activities and group-based knowledge development [2]. The enlarged needs especially of cooperation in order to foster the integration of a vast heterogeneity of knowledge resources and diverse learning and working cultures separates PSS from traditional, e.g. product-oriented, work environments [3]. Thus, the growing importance of PSS work environments and their special characteristics, with a distinct demand for innovative problem-solving capabilities compared to traditional work environments, require different methods and tools for employees in the engineering and the higher

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education sector in order to meet the demands of the transformation from a pure product or pure service orientation to PSS [4,5,6].

The number of tailored business games as a learning method is receiving increasing awareness, especially for addressing learning requirements regarding the understanding of complex systems [7,8]. In servitization literature, the method of business gaming with a special focus on understanding customer integration demands has been adapted through a case study approach at a manufacturer [9]. Business games are regarded as particularly useful to provide a realistic but risk-free and engaging learning environment for individuals. The participation in a PSS-specific business game can increase the learning output for employees in the engineering sector through reality analogous situations within a learner-centered PSS-related scenario [8,9,10,11]. Learners have the opportunity to take actions in a group setting, while they receive immediate feedback about the outcome of their actions [7]. Business games are considered as a methodical approach which is very flexible and adaptable to the dynamics of real-life work environments and can be used to initiate a knowledge- and experience-sharing process between heterogeneous groups of experts within a playful as well as authentic learning context [9,11]. Thus, we argue that this approach can be considered as an appropriate method for the development of a PSS-related learning scenario that helps individuals to collectively understand and learn about the challenges of the transformation towards a PSS work environment [12,13,14]. We, therefore, seek to design a PSS-specific learning scenario that is based on recent theoretical concepts of learning on an individual, group and organizational level. The concept provides a context-rich learning environment, while focusing on key challenges of the transformation process towards PSS.

This leads us to our main research questions: How can the design of a game-based learning scenario contribute to the understanding of the transformation process and its challenges from a product- or service-oriented business towards PSS, and how can the learning outcomes be evaluated?

To provide an answer to this question, we introduce the main characteristics of PSS-related work environments and summarize how these can be differentiated from product- and service-related work environments. The transformation process towards PSS will be characterized by the level of integration of products and services which goes hand in hand with the development and learning processes of the organization [15,16,17,18]. The 4I Framework, as a process-oriented model of organizational learning and development, provides the theoretical fundament of this paper [19]. The dynamics of the transformation process across the individual, group and organizational level will be covered with the help of a business game concept that provides a learner-centered method with insights about this complex process [9]. As our learning scenario builds on a game-based approach, individuals can exert influence on a fictitious transformation process through contextualized activities in the PSS-related scenario. The evaluation concept for individual learning outcome will be based on the activities in the business game environment.

2. Conceptual background of the learning scenario design

2.1. Challenging characteristics of PSS

The shift from product orientation to a hybrid offering as a combination of tangible products and intangible services is a complex process that has a fundamental impact on the whole organization [16,20]. Recent literature about PSS and the servitization of manufacturing describes this process as an iterative transformation process rather than a sudden revolutionary change [21]. The levels or steps of transformation can be further determined by the shift from product-dominated to service-dominated logic based on the change of an organization's business model [17,18,22]. Brax [21] postulates, based on a qualitative research study within a manufacturing company regarding industrial services, that "becoming a provider of industrial services is not just a matter of the offering; the whole organization needs to re-focus its attention" [21, p.152]. The author summarizes, moreover, increasing challenges for manufacturers introducing industrial services, e.g. a higher relevance of information management systems and knowledge-sharing procedures as well as the increasing requirement for customer integration into the value creation processes of the organization [21, p.151].

These findings support our own recent research results from a quantitative study among German engineers [3]. The study revealed that typical phenomena within PSS-oriented work environments are innovative ways of learning new things, external-oriented communication strategies and a higher degree of collaborative work processes within heterogeneous groups of experts. Furthermore, the integration of the service-oriented and the product-oriented paradigm raises two paradigmatic challenges which we consider as special characteristics of PSS work environments that result from the integration of the product- and the service-dominated logic of organizations [3]. Paradigmatic challenge 1: On the one hand, PSS work environments show a high degree of openness with regard to external partners and innovation-orientated work processes. On the other hand, they can still be characterized by a relevant amount of standardization facets which are traditionally typical for product-related or transactional-oriented organizations [see also 21]. Paradigmatic challenge 2: An important role of leadership lies in the objective to motivate employees so that they find new ways in which to deal with and solve current and future problems to secure a high level of innovation of PSS. By contrast, there are also significant facets of hierarchical-oriented leadership elements shown in PSS-oriented work environments. This underlines the ambidextrous character of leadership in PSS work environments as well as the

importance of knowledge generation and knowledge management [2].

In summary, we argue that the increasing relevance of PSS from an economic or market opportunities point of view [23,24], as well as the increasing demands of PSS regarding sustainable knowledge generation, effective information sharing, and thus, the requirement of innovative problem-solving strategies in a working context that is characterized by a high degree of heterogeneity raises the need for a PSS-related learning scenario. The learning scenario should help individuals to understand the general concept of a PSS-oriented business model and to cope with the high degree of ambiguity in a knowledge and communication intensive work environment. Hence, a PSS-specific learning scenario should address the following four main categories: the concept of a PSS business model, the transformation process towards a PSS, the characteristics of a PSS work environment, and the solutions how to deal with the demands of PSS.

2.2. Conceptualization of the learning process

The conceptual design of our PSS-related learning scenario refers to the approach of situated learning and situated cognition [25]. The fundamental design concept of situated learning is the combination of abstract knowledge with a relevant context or applicable situation [25]. Following this conceptual framework, we argue that participants of a PSS-related learning scenario need to get the opportunity to experience the transformation process from a product- or service-oriented business towards PSS due to its dynamic characteristics and ambiguity, which can better be understood by learners through a contextualization of abstract knowledge about this process. Therefore, the paradigmatic challenges of PSS-related organizations mentioned above should be addressed. Furthermore, the possibility for learners to develop their own solutions related to challenges regarding the integration of products and services should be provided to generate an understanding of the characteristics of PSS.

Providing a general conceptual context for learners in the sense of a PSS-related situated learning environment, we build our learning scenario on the theory of organizational learning. Crossan et al. [19] argue that "organizational learning can be conceived of as a principal means of achieving the strategic renewal of an enterprise" [19, p.522]. Taking into account that the transformation process of a product- or service-oriented organization towards PSS is considered as strategic renewal of an organization, we rely on the 4I Framework of organizational learning developed by Crossan et al. [19]. A key aspect of the transformation towards PSS is to find appropriate solutions of integrating diverse knowledge from the product and the service business logic [e.g. 24]. Therefore, the 4I Framework provides an approach regarding how the (re)combination and (re)allocation of knowledge of heterogeneous actors and different knowledge domains can be accompanied in PSS [3]. In particular, the processes of interpreting and integrating knowledge as multi-level processes of the 4I Framework make diverse individual- and group-related (expert) knowledge accessible and useable on an organizational level (see Figure 1).

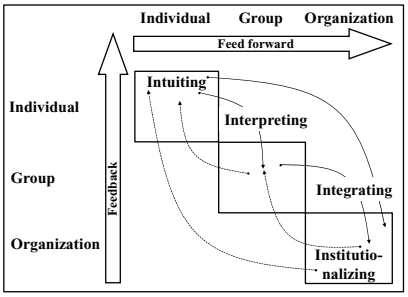

Figure 1: 4I Framework by Crossan et al. [19]

Crossan et al. [19] describe the process of interpreting as the development of an understanding about domain-specific knowledge among individuals in a work group and their individual actions connected to a group interpretive process [19,26]. With the help of this process, domain-specific knowledge can be established on a group level through sharing individual cognitive maps of a certain domain. In contrast to the interpreting process, the integration process puts emphasis on the requirement of collective understanding of work-related situations and problems for successful collective actions. Crossan et al. [19] refer to Seely-Brown and Duguid [27], who underline the necessity of establishing "continuing conversation among members of the community and through shared practice" [19, p.528, with reference to 27] to ensure the accessibility of relevant knowledge at the organizational level. In summary, the capabilities, and thus, the active participation of individual actors in a community-related context are regarded as critical success factors for organizational learning and, consequently, the transformation process towards PSS.

The challenges and the dynamics of actively contributing to such an integrative learning process across different social or physical environments, such as a product and a service environment can be addressed by the concept of legitimate peripheral participation (LPP) [10]. Based on LPP, individuals learn how to contribute to a community's objectives through, for example, the acquisition of a community-related subjective viewpoint, the learning of a certain language or communication habits used in this community [see also 28]. Wenger [29] introduced a special form of learning-oriented communities called Communities of Practice (CoP). In a CoP, collective knowledge, symbol systems, resources, and tools are shared and further developed among a group of individuals [29,30]. Participants of a CoP produce and shape the shared repertoire of, for example, routines, stories or languages that also differentiates one community from another. Wenger and Snyder [31] define CoP as "a group of people informally bound together by shared expertise and passion for a joint enterprise" [31, p.139]. Connected to the integration of products and services, we understand the shared practices of a PSS-related community as those aspects of the product or the service logic that are considered as valuable in an evolving community to adopt or keep as collective

resources. Hence, regarding designing a PSS-related learning scenario, the model of CoP provides us with an underlying evolutionary concept about how individuals can contribute to achieve the integration of the product and the service paradigm in a learning scenario that follows the procedural steps of the 4I Framework.

As a PSS depends on the integration capabilities of, for example, a manufacturer, a service provider and a customer, the concept of CoP can be adopted. The design and development phases of a PSS are especially knowledge and communication intensive due to the cooperation requirements of heterogeneous groups of experts [2,24]. Thus, we argue that a large amount of the proposed learning needs can be addressed with the help of a learning environment that provides individual learners with the knowledge about how to collaborate in the sense of a CoP in order to manage the integration of products and services. Furthermore, the positive contribution of a CoP to the degree of innovative output of organizations is also discussed in management literature [e.g. 30].

The transfer of the conceptual approaches above into a PSS-related learning scenario can be achieved using the method of business gaming. In general, the approach of gaming is broadly accepted as an appropriate method that provides a basis for the development of a CoP through the integration of several social factors to support learning- and knowledge-sharing processes. Typical social factors in (business) games are, for example, status seeking, acknowledgement or social affiliation [32]. In addition, the method of business gaming builds on the theory of gaming which defines strategic gaming as a study of players' interdependent interactions, while considering their respective payoffs [33]. Consequently, a typical challenge in a business game from a learner's point of view is to work out a strategy to deal with goal conflicts, uncertainty or a high degree of ambiguity in virtual but reality-oriented business environments. Payoffs or rewards in business games are characterized by a set of context-specific key performance indicators that reflect the success of actors (as individuals or a group). From a learner's activation and decision-making point of view, game theory offers a scientific approach towards how strategic decision-making can happen. Context-relevant anecdotes, cases, stories, and examples are offered as anchors or advice for situated decision-making [11]. Business games as a didactical method provide an appropriate platform for understanding how different actions affect each other related to a certain context and how problem-solving strategies can be applied collaboratively [11,32]. Dixit and Skeath [34] stated the three contributions of games to learning requirements, which also refer to the field of business games, and underline the usage of this method for a PSS learning scenario [34]:

- Explanation – When the situation involves interaction of decision-makers with different aims, Game Theory supplies the key to understanding the situation and explains why it happened.
- Prediction – When looking ahead to situations where multiple decision-makers interact strategically, people can use Game Theory to foresee what actions they will take and what outcomes will result.
- Advice or Prescription – Game Theory can help one participant in the future interaction, and tell him/her which strategies are likely to yield good results and which ones are liable to lead to disaster.

3. Design of a PSS-specific game-based learning scenario

For the design of a PSS specific game-based learning scenario we refer to the generic model of games and simulations consisting of three main components: social actors, rules and a reference (see Figure 2). This general model of games and simulations determines how learners (actors) in a business game scenario "interact with one another, while applying rules, and utilizing resources" [11, p.48].

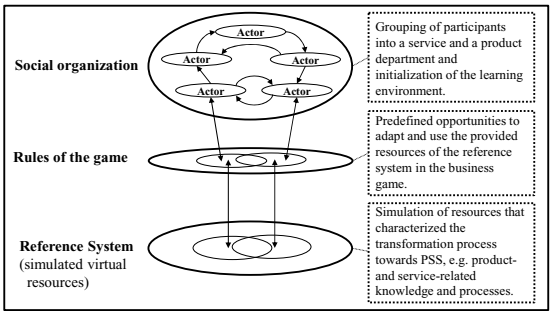

Figure 2: A generic model of games and simulations adapted for PSS

Thus, situation-related learning processes of the participants are created and influenced by the design of the specific game rules, the characteristics of the resources available through the course of the game, and the targets participants of the game are supposed to achieve. In our conceptual design, learners are the actors within a fictitious organization which is transforming towards a PSS provider. They have to manage the transformation process in a reality analogous setting determined by rules and the reference system. In this game-based modeling approach, we prefer to rely on a case study of a manufacturing company which provides a relevant example that can be applied to the business game model. The business game reflects the general steps of the transformation process towards a PSS based on servitization literature [e.g. 15,17]. As learners enter the game-based learning scenario, the rules of the business game predefine the role of learners within the fictitious organization. Learners become actors in a manufacturing company characterized by a product-oriented business model that is changing stepwise towards a PSS oriented business model [17]. Individual learners are grouped into representatives of a customer service and a product

management department which are clearly separated from each other. The flow of the business game scenario follows the 4I Framework [19], while the original framework (see Figure 3) has been extended due to our focus on the integration of the product and the service logic (see Figure 3).

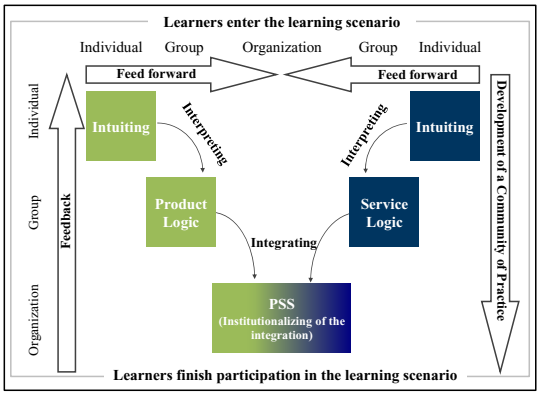

Figure 3: PSS-related 4I Framework (inspired by Crossan et al. [19])

Along the four steps of the 4I Framework of Intuiting, Interpreting, Integrating and Institutionalizing, the learning scenario confronts learners with opportunities, barriers, available resources, and potential risks throughout fictitious situations they have to deal with to manage the process towards the integration of products and services while the paradigmatic challenges (see section 2.1) arise. However, the integration of both paradigms is required for the institutionalization of a PSS (see Figure 3).

4. Evaluation of the learning scenario

The design of the PSS-related learning scenario is built on a specific 4I Framework introduced in section 3. The success in the business game-based learning scenario, as specified in the previous section, depends on the capabilities of developing routines, rules and procedures between two initially separated groups or departments that are independently introduced to the product and the service paradigm at the beginning of the game scenario. During the course of the business game, participants absorb paradigmatic elements (product- or service-related) of their domain as a group through the interpreting process. This leads to the development of group-based cognitive maps and languages (see Table 1). As the simulation game proceeds to the integrating phase, the groups have to learn to adapt new practices of the other paradigm (product or service) and give up their own elements of their knowledge practices. Keeping pure product or pure service elements unchanged can lead to barriers in the integration process towards PSS. The development of shared practices between members of the product and the service department is initiated. Thus, as long as both groups do not develop communication and collaboration methods about how to integrate information and knowledge, they will not be able to reach the level of institutionalization in the sense of the 4I Framework. An underlying understanding of the advantages as well as new routines of sharing practices and integrating knowledge and information between the two departments can be established among the learners. During the steps of this process Crossan et al. specified certain input and output factors related to the four processes from Intuiting to Institutionalizing that can be measured as "achievements" during the course of the business game (see Table 1).

Table 1: Individual Learning Outcomes along the PSS - 4I Framework (inspired by Crossan et al. 19, p.525])

Level	Process	Inputs Outcomes	Individual Learning Outcomes
Individual	Intuiting	Experiences Images Metaphors	Knowledge about characteristics of product & service paradigm
Group	Interpreting	Language Cognitive map Conversation / dialogue	Understanding about product & service paradigm related to the department
	Integrating	Shared understanding Mutual adjustment Interactive systems	Understanding about differences of product & service paradigm and linkage of the integration challenges
Organization	Institutionalizing	Routines Diagnostic systems Rules and procedures	Development of principles/procedures for product service integration

At the point of entrance into the PSS-related learning scenario, the learners will bring in previous experiences and images related to the context of the business game. These will be shaped at the start of the learning scenario, as we intentionally establish a pure product paradigm (product department) and a pure service paradigm (service department) among the learners. A successful integration of both paradigms towards a PSS during the course of the business game is supposed to lead to a deeper understanding about the relations of the "magic triangle" of product orientation, service business and the PSS concept. Regarding the learning outcome of individuals, the understanding of the PSS concept in general, the transformation process towards PSS and a repertoire of appropriate solutions or procedures how to deal with challenges in PSS work environments we use Sugrue's model of cognitive components of problem-solving [35]. This model refers to the measurement of the understanding of concepts, principles that link concepts, and the linking of concepts and principles to conditions and procedures (see learning outcomes, Table 1). We aim to compare the effectiveness of our learning scenario with other methods of teaching that also refer to PSS.

5. Conclusion

The successful elimination, reallocation and recombination of product- and service-related paradigm facets are crucial for the transformation towards PSS. In our learning scenario, we propose that individuals, groups and organizations have to

leave routines behind, adopt them or change them through the development of shared practice comparable to a CoP. This process is characterized by a high degree of communication, coordination and collaboration, while it can take place among heterogeneous groups of experts. Thus, the conceptual design of our proposed learning scenario stresses these PSS-specific demands through enabling and supporting individuals to actively contribute to this integration process using the method of business gaming. While we refer to the design of a business game to initiate the integration process of products and services from an organizational development point of view, we argue that the culture of learning will change, while elements of former organizational paradigms are left behind. The design of our scenario builds on the PSS-specific demand of a strategic organizational renewal process which indicates changes across the whole organization. Our paper here contributes to the scientific community with a PSS-related 4I Framework that focuses on critical aspects of a PSS-specific organizational development process and its challenges. This serves as a fruitful base for further research about the transformation of manufacturing towards PSS with regard not only to research in the area of individual learning, but also group and organizational leaning in PSS-oriented work environments.

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